IS 7931-2 (1975): Automatic and semi-automatic welding equipment with self-adjusting arcs (MIG/MAG Processes): Part 2 Transformer rectifier power source [ETD 21: Electric Welding Equipment]

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(Reaffirmed 2004)

Indian Standard

SPECIFICATION FOR AUTOMATIC AND SEMI-AUTOMATIC WELDING EQUIPMENT WITH SELF-ADJUSTING ARCS (MIG/MAG PROCESSES)

PART II TRANSFORMER-RECTIFIER POWER SOURCE

(First Reprint FEBRUARY 1988)

UDC 621.791.03:621.314.254.8:621.791.75

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NEW DELHI 110002

Gr 4

April 1976

Indian Standard

SPECIFICATION FOR AUTOMATIC AND SEMI-AUTOMATIC WELDING EQUIPMENT WITH SELF-ADJUSTING ARCS (MIG/MAG PROCESSES)

PART II TRANSFORMER-RECTIFIER POWER SOURCE

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PART II TRANSFORMER-RECTIFIER POWER SOURCE

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 30 December 1975, after the draft finalized by the Electric Welding Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 There are numerous variations of arc welding processes using consumable electrode wires. The wire may be solid or composite, and with or without flux. In all these cases, the melting generally takes place in the presence of a shielding gas. This gas may be inert (for example, argon) or have a definite chemical activity at the high temperature of the electric arc (for example, carbon dioxide). When the shielding gas is inert the welding process is known as MIG process and when this gas has a definite chemical activity at the high temperature of the electric arc this process is called MAG process.

0.3 This standard on automatic and semiautomatic welding equipment is being issued in three parts. This part covers transformer rectifier power sources while Part I covers dc generator power sources and Part III welding gun and ancillary equipment.

0.4 In preparing this standard, assistance has been derived from the following:

ISO Doc: TA-76/72/E Specification of arc-welding equipment using consumable wires (MIG/MAG processes). International Organization for Standardization.

Doc: 71/42369 Draft British Standard Specification for arc welding plant, equipment and accessories (*revision* of BS 638 : 1966). British Standards Institution.

NEMA EW-1-1970 Electric arc welding apparatus. National Electric Manufacturers' Association, USA.

0.5 Rectifier type power source could be either with ac/dc output or dc output only. This standard is intended to cover power source with dc output only.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part II) covers transformer-rectifier power source of the substantially flat load characteristics type incorporating monocrystalline and polycrystalline rectifiers for semiautomatic and automatic arc welding with self-adjusting arc (MIG/MAG processes). Equipment covered by this standard will normally be of the air cooled or forced air cooled type.

1.1.1 This standard does not cover oil cooled transformer rectifier power source.

1.2 The windings of transformer-rectifiers covered by this standard are of insulation classes A, E, B, F and H.

1.3 Welding transformer-rectifier covered by this standard are assigned ratings on the basis of duty cycle.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in **2** of IS : 7931 (Part I)-1975†, in addition to **2.1**, shall apply.

2.1 Transformer-Rectifier Power Source — A transformer-rectifier with associated reactors, control windings, control and indicating devices required to produce direct current for arc welding.

3. DESIGN AND CONSTRUCTION

3.1 The rectifier assembly shall be isolated from the mains supply by a double wound transformer. All output terminals shall be suitably shielded against accidental or inadvertant contact.

*Rules for rounding off numerical values (*revised*).

†Specification for automatic and semiautomatic welding equipment with self-adjusting arcs (MIG/MAG processes) : Part I DC welding generator power source.

3.2 Monocrystalline rectifiers shall be of adequate current-carrying capacity and able to withstand, with surge protection devices if fitted, transient voltages likely to occur from arc welding and allied processes. Monocrystalline semiconductor rectifiers shall comply with IS : 4540-1968*.

3.3 Polycrystalline rectifiers (metal rectifiers) shall comply with IS : 3136-1965† in so far as it does not conflict with the requirements specified in this standard.

3.4 Where forced draught cooling is used, an automatic device which switches off the rectifier or reduces the output to a safe level in the event of inadequate airflow shall be fitted.

3.5 The loading of rectifier assembly shall be such that its temperature-rise shall not exceed the value stipulated by the rectifier manufacturer at the rated output.

3.6 It is recommended that the minimum standard of enclosure for the rectifier plant shall be drip-proof.

3.7 The welding power source shall be capable of withstanding the full specified supply voltage without the necessity for reforming the rectifier cells by the application of reduced voltage. The welding power source shall also be capable of withstanding an ac voltage instantaneously applied and maintained for 5 minutes which is 10 percent higher than the voltage appropriate to the selected primary voltage tapping. It shall also be able to withstand repeated switching of the ac supply at the same excess voltage when the dc output terminals are not connected to an external load.

3.8 Capacitors may be used to improve the power factor to approximately 0·8 lagging at 50 percent of the maximum continuous automatic/semi-automatic welding current and the corresponding load voltage.

3.8.1 The capacitors if provided as part of the welding plant, shall conform to IS : 2834-1964‡.

3.8.2 The capacitors shall be so connected that they are switched off with the welding plant.

4. RATING

4.1 Voltage — It is recommended that the voltage between the output terminals of a rectifier should not exceed a mean dc value of 100 V.

*Specification for monocrystalline semiconductor rectifier assemblies and equipment.
†Specification for polycrystalline semiconductor rectifier equipment.
‡Specification for shunt capacitors for power systems.

4.2 Rated Current — The welding transformer rectifier shall be rated at currents at duty cycle corresponding to maximum continuous semi-automatic welding current and maximum automatic welding current. Preferred current ratings shall be 150, 200, 250, 300, 400, 500, 600 and 800 A.

4.3 The maximum continuous automatic welding current for air cooled rectifier plant for automatic single metal-arc welding shall be that corresponding to 100 percent duty cycle.

4.4 The maximum continuous semiautomatic welding current for air cooled rectifier plant for semiautomatic single metal arc welding shall be that corresponding to an 85 percent duty cycle. This comprises a complete cycle consisting of a period of 4·25 minutes under the conventional operating conditions followed by a period of 0·75 minute of no-load operation.

5. MARKING

5.1 Rating Plate Information — The following information shall be given on the rating plates:

a) Manufacturer's name and/or trade-mark;

b) Manufacturer's type, designation and serial number;

c) Maximum continuous automatic welding current/Maximum continuous semiautomatic welding current;

d) Maximum semiautomatic welding current/Maximum automatic welding current;

e) Maximum open circuit voltage;

f) Input volts, current, frequency;

g) Type of cooling;

h) Insulation class; and

j) A warning as follows:

'*Warning* — Currents in excess of the following are for intermittent use only:

1) For semiautomatic welding.....Amp.

2) For automatic welding..... Amp.

5.2 The transformer rectifier assembly may also be marked with the the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6. TESTS

6.0 Tests shall be made to prove compliance with all the requirements of this standard.

6.1 Type Test — These tests may be made by mutual agreement between the purchaser and the supplier and if the records of type tests on a transformer rectifier power source which in essential details is representative of the one being purchased are furnished, the purchaser may accept these as evidence of type tests instead of actual test. The type tests and their sequence shall be as follows:

a) Insulation resistance test (*see* **6.3**);

b) Overvoltage test (*see* **6.4**);

c) Open-circuit voltage test (*see* **6.5**);

d) Test for load characteristic (*see* **6.6**);

e) Temperature-rise test (*see* **6.7**); and

f) High voltage test (*see* **6.8**).

6.2 Routine Tests — Routine tests shall comprise the following:

a) Insulation resistance test (*see* **6.3**);

b) Open-circuit voltage test (*see* **6.5**);

c) Test for load characteristic (*see* **6.6**); and

d) High voltage test (*see* **6.8**).

6.2.1 A certificate of routine test shall be furnished by the manufacturer which shall show that each welding set has been tested and has been found to be sound electrically and mechanically and is in working order in all particulars and that it complies with the terms of this specification.

6.3 Insulation Resistance Test — The insulation resistance shall be measured with a dc voltage of about 500 volts applied for a sufficient time for the reading of the indicator to become practically steady, such voltage being taken from an independent source or generated in the measuring instrument. The insulation resistance shall be not less than two megohms.

NOTE — Rectifier cells shall be short-circuited before performing the test.

6.4 Overvoltage Test — The overvoltage test shall be carried out at the voltage specified in **3.7** followed by repeated switching of the ac supply, 50 times at the same excess voltage when the dc output terminals are not connected to an external load.

6.5 Open-Circuit Voltage Test — With the input side connected to the supply voltage and output side open-circuited, the open-circuit voltage shall be measured. Open-circuit voltage for the various positions of the coarse and fine controls on the machine shall be measured. The permissible tolerance for maximum value of open-circuit voltage shall be ± 5 percent.

6.6 Test for Load Characteristic — With the transformer rectifier connected to the supply, the associated load currents and load voltages are measured at the output terminals of the transformer rectifier through a resistive load.

The values of welding currents and associated voltages shall be as agreed to between the manufacturer and the purchaser. For general guidance the associated load currents and load voltages shall be given by the following equation:

$$U_2 = 14 + 0{\cdot}05\, I_2$$

where

U_2 = welding load voltage, and

I_2 = corresponding value of the welding current.

The permissible tolerances for rated values of current shall be ± 10 percent.

6.7 Temperature-Rise Test

6.7.1 Test Conditions

6.7.1.1 The load should be a non-inductive resistance and at the appropriate load voltage. A tolerance of ± 10 percent should be allowed on the value of this load voltage.

6.7.1.2 Test shall be made using the input winding tap corresponding to the voltage being applied.

6.7.1.3 The temperature-rise test shall be carried out at a current equal to the maximum continuous automatic welding current and at a duty cycle equal to 100 percent. The measurement of temperature shall be made in accordance with Appendix A.

6.7.1.4 If the transformer is for semiautomatic welding only, it shall be tested at an equivalent continuous maximum welding current arrived at by using the formula:

$$\text{Maximum continuous automatic welding current} = 0{\cdot}92 \times \text{maximum semi-automatic welding current}$$

6.7.1.5 The test shall continue until steady maximum temperature is obtained. If the temperature-rise does not vary by more than 2°C per hour it is considered that steady temperature has been achieved.

6.7.2 The temperature-rise shall not exceed the limits specified in Table 1.

6.7.3 *Reduced Temperature-Rises for Transformers Designed for High Altitudes* — For transformers designed for operation at an altitude greater than 1 000 m, but tested at normal altitudes, the limits of temperature-rise given in Table 1 are reduced by the following amounts for each 500 m by which the intended working altitude exceeds 1 000 m:

a) Oil-immersed, natural-air-cooled transformers	2·0 percent
b) Dry-type, natural-air-cooled transformers	2·5 percent
c) Oil-immersed, forced-air-cooled transformers	3·0 percent
d) Dry-type, forced-air-cooled transformers	5·0 percent

NOTE — These reductions in temperature-rise limits are not applicable to water-cooled transformers.

6.8 High Voltage Test

6.8.1 The high voltage test shall be carried out once and to a new machine only. It shall be carried out at the manufacturers works at the conclusion of the temperature-rise test if conducted. If the manufacturer has carried out this test, at his works, this shall not be repeated by the testing authority.

NOTE 1 — Protective or filter devices or capacitors or fans shall be disconnected or short-circuited as desired.

NOTE 2 — The rectifier cells shall be short-circuited, before performing the test.

TABLE 1 LIMITS OF PERMISSIBLE TEMPERATURE-RISE IN °C

(*Clause* 6.7.2)

Sl No.	Parts	Class of Insulation									
		Class A		Class E		Class B		Class F		Class H	
		T	*R*	*T*	*R*	*T*	*R*	*T*	*R*	*T*	*R*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	Windings	55	60	65	75	70	80	85	100	105	125
ii)	Oil	50	—	—	—	—	—	—	—	—	—
iii)	Insulated parts including cores not in contact with insulated windings.	The temperature-rise shall in no case reach such a value that there is risk of injury to any insulating material on adjacent parts or to the welding plant in any respect									

R = by resistance

T = by thermometer

NOTE 1 — The numerical values quoted for classes F and H should be considered as tentative only and may be revised when more practical experience is available. If class C insulation is used, the temperature-rise shall be a matter of agreement between the purchaser and the supplier.

NOTE 2 — For details of classes of insulation, *see* IS : 1271-1958 'Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service'.

6.8.2 The test shall be made with a single-phase alternating voltage as nearly as possible of sinewave form and of any convenient frequency between 40 and 60 Hz. The rms value shall be 2 kV.

6.8.3 The appropriate voltage, obtained from a separate source, shall be applied for 60 seconds to each winding in turn, between the winding under test and the remaining windings, core, frame and tank or casing of the transformer rectifier assembly, connected together and to earth.

6.8.4 The test shall be commenced at a voltage not greater than one-third of the test value, and shall be increased to the specified value as rapidly as is consistent with its magnitude being indicated by the measuring instrument. At the end of the test the voltage shall be reduced rapidly to less than one-third of its full value before switching off.

APPENDIX A

(*Clause* 6.7.1.3)

TEMPERATURE MEASUREMENTS

A-1. METHODS

A-1.1 Two methods of measuring temperature are recognized, namely:

a) Resistance method, and

b) Thermometer method.

A-1.2 Resistance Method — In this method, the temperature-rise of the winding shall be determined by the increase in the resistance of the windings. However, if desired, a check may be made by thermometers applied to the accessible surfaces of the windings and the temperature-rise thus determined shall not exceed the permissible limit specified for the resistance method.

A-1.2.1 The temperature of the windings as measured by thermometer before commencing the test shall not differ from that of the ambient. The initial resistance and initial temperature of the windings shall be measured at the same time.

A-1.2.2 Since the resistance over the range of temperature referred to in this standard varies in direct proportion to the temperature above a particular value, the hot temperature is obtained from the following equation:

$$t_2 = (R_2/R_1) (t_1 + X) - X$$

where

t_2 = temperature of hot windings in °C,

R_2 = resistance of hot windings,

R_1 = resistance of cold windings,

t_1 = temperature of cold windings in °C, and

X = 234·5 for copper and 229·8 for aluminium.

NOTE — The value of 229·8 for aluminium is based on 3/4H condition and conductivity of 60·6 percent International Annealed Copper Standard. If the conductivity is different, this may have to be altered.

A-1.2.3 If the variation of resistance method is not applicable (for example, in the case of a low resistance winding where the resistance of the joints and connections constitute a considerable part of the total resistance) as far as possible use is made of thermometer set up during the test on the external face of the windings and the temperature-rise limit given in Table 1 is retained.

A-1.3 Thermometer Method — When using this method, the temperature shall be measured by thermometers applied to the hottest accessible surfaces*, of transformer during the test period.

A-1.3.1 The term 'thermometer' means mercury or alcohol bulb thermometer. In measuring temperature, thermocouples or resistance thermometers may be substituted for liquid-in-glass thermometers provided such instruments were inserted in narrow interstices which would be accessible to the bulb of normal thermometer not less than 5 mm.

A-1.3.2 The bulb of the thermometer, except at the point of contact, shall be covered with a pad of felt, cotton wool or other non-conducting material 3 mm thick extending at least 20 mm in every direction from the bulb and pressed into contact with the surfaces to which this is applied, to prevent loss of heat by radiation and convection from the bulb.

A-2. PRECAUTIONS TO BE OBSERVED IN MAKING RESISTANCE MEASUREMENTS

A-2.1 Special care should be taken when measuring the temperature of windings by this method to ensure that apparatus and method of adequate accuracy are used.

A-2.2 To determine temperatures of the windings when hot, an accurate measurement of resistance and associated temperature should be taken when the windings are cold.

A-3. MEASUREMENT OF TEMPERATURE OF AMBIENT

A-3.1 In general, the temperature of the ambient shall be measured by means of several thermometers placed at different points around and halfway up the transformer and at a distance of 1 to 2 m away from it. These thermometers shall be so placed as to indicate the temperature of the current of air flowing towards the transformer and shall be protected from heat radiation and stray draughts.

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*The term 'accessible surfaces' is intended to convey that the established limits of temperature-rise of windings measured by thermometer are based on the use of thermometers placed on the external surfaces of the windings or iron cores with which the windings may be in contact. The measurements are not intended to cover readings which might be obtained by inserting thermometers into narrow interstices between coils, or between insulating flanges and coils. In such locations the temperature may be higher and allowance is made for this in fixing the permissible temperature-rises measured at the surface.

The fact that the type of construction renders a winding difficult of access is not to be taken as permission to operate such windings at higher temperature than are allowed on those windings or portions of windings on which the thermometers can be more easily placed, and the standard limits of temperature-rise should not be exceeded on any winding surface. If a reasonable proportion of the windings is readily accessible to a thermometer, temperature-rise should be determined by a thermometer placed on these portions of the windings.

A-3.2 Where temperature tests are carried out under such conditions that parts of a transformer are in a position in which ventilation may be impeded, for example, in a pit, the temperature, in such a restricted area shall be deemed to be the ambient temperature.

A-3.3 If the air is admitted into the transformer through a definite inlet opening or openings, the temperature of the ambient shall be measured by means of thermometers placed in the current of incoming air near the place it enters the transformer.

A-3.4 The value to be adopted for the temperature of the ambient during the temperature-rise test shall be the average of the reading of the thermometers mentioned above, taken at the beginning and the end of the last half hour of the test.

A-3.5 To avoid errors due to the time lag between the temperatures of a large transformer and the variation in the temperature of the ambient and all reasonable precautions shall be taken to reduce those variations and the errors arising from them.

A-4. TIME AT WHICH TEMPERATURES ARE TO BE TAKEN

A-4.1 The temperature of transformer shall, whenever possible, be taken during working as well as after shutting off the transformers. The highest temperature thus obtained shall be adopted. When successive measurements show increasing temperature after shut-down, the highest value shall be taken.

A-5. TEMPERATURE-RISE

A-5.1 The temperature-rise shall be the difference between the highest temperature measured under **A-4** and the mean temperature measured under **A-3**.

INDIAN STANDARDS

ON

ELECTRIC WELDING EQUIPMENT

IS :

1851-1975 Single operator type arc welding transformers (*second revision*)

2635-1975 dc electric welding generators (*second revision*)

2641-1964 Electrical welding accessories

4559-1968 Single operator rectifier type dc arc welding power source

4804 (Part I)-1968 Resistance welding equipment: Part I Single-phase transformers

4804 (Part II)-1968 Resistance welding equipment: Part II Single-phase rocker-arm spot welding machines

4804 (Part III)-1969 Resistance welding equipment: Part III Single-phase spot and projection welding machines

4804 (Part IV)-1973 Resistance welding equipment: Part IV Single-phase stationary, press type roll-spot and seam welding machines

6008-1971 Single operator ac/dc arc welding power source

7931 (Part I)-1975 Automatic and semiautomatic welding equipment with self-adjusting arcs (MIG/MAG processes): Part I DC welding generator power source

7931 (Part II)-1975 Automatic and semi-automatic welding equipment with self-adjusting arcs (MIG/MAG processes): Part II Transformer-rectifier power source

7931 (Part III)-1975 Automatic and semi-automatic welding equipment with self-adjusting arcs (MIG/MAG processes): Part III Welding gun and ancillary equipment

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AMENDMENT NO. 1 JULY 1989
TO
IS : 7931 (Part 2) - 1975 SPECIFICATION FOR AUTOMATIC AND SEMI-AUTOMATIC WELDING EQUIPMENT WITH SELF-ADJUSTING ARCS (MIG/MAG PROCESSES)

PART 2 TRANSFORMER-RECTIFIER POWER SOURCE

(*Page* 6, *clause* **4.4**) — Substitute the following for the existing clause:

'**4.4** The maximum continuous semi-automatic welding current for air-cooled rectifier plant for semi-automatic single metal arc welding shall be that corresponding to 60 percent duty cycle in case of general applications and 75 percent duty cycle in case of heavy duty applications.'

(ETDC 21)

Printed at Printwell Printers, Delhi, India